Development of Renewable Microbial Polyesters for Cost-Effective and Energy Efficient Wood-Plastic Composites

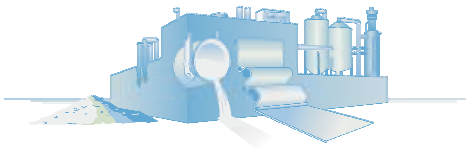
Economic Method for Replacing Petroleum-Based Plastics Offers Significant Energy and Environmental Benefits

Wood-fiber reinforced thermoplastic composites (WFRTCs), or wood-plastic composites, are increasingly used in durable applications within the building/construction and furniture industries. Since 1997, this market for WFRTCs has grown at an average annual rate of 38 percent.

WFRTCs contain an average 40 percent by weight of petroleum-based thermoplastics, primarily high-density polyethylene (HDPE). The use of bio-based thermoplastics in place of petroleum-derived products would reduce dependence on petroleum for their production. However, bio-based products are not currently used due to their substantially higher production costs.

This project is developing cost-effective means of using unpurified, renewable, and biodegradable polyhydroxyalkanoates (PHAs), or microbial thermoplastic polyesters, in place of petroleum-derived plastics to create wood-plastic building materials. By producing these biomaterials from waste effluents, the substrate costs will be greatly reduced. In addition, by utilizing the PHA-laden cells directly in composites without purification, the purification steps, which account for a majority of the production costs, will be eliminated.

A pilot extrusion line, left, and a collection of sections of different extruded structural wood plastic composites, right.



Benefits for Our Industry and Our Nation

The use of renewable biomaterials in wood-plastic materials production would yield energy savings of over 310 trillion Btu (British thermal units) by 2020 if deployed across the building/construction industry. As early as 2010, reductions in NO_X, CO, and SO_2 could be 8, 2, and 16 percent, respectively, of the total emissions of these pollutants in polymer and resin manufacturing. Significant environmental benefits will also be realized by the wastewater treatment industry in the municipal, industrial (pulp mill), and agricultural sectors.

Applications in Our Nation's Industry

Successful development of methods for using biomaterials in place of traditional products would aid the entire forest products industry in reducing its dependence on foreign petroleum.

Project Partners

Idaho National Laboratory
Idaho Falls, ID

Washington State University
Pullman, WA

University of California-Davis
Davis, CA

ECO:LOGIC Engineering, Inc.
Rocklin, CA

NewPage Corporation
Chillicothe, OH

Strandex Corporation
Cincinnati, OH

Project Description

The goal of this project is to manufacture wood-thermoplastic composites using unpurified, renewable, and biodegradable PHA feedstocks produced from waste effluents. The PHAs will be produced directly in pulp and paper mill wastewater treatment processes or in side-stream reactors at the pulp and paper mill, by bacteria inherent to the treatment processes, and will utilize pulp mill effluents as the carbon sources.

Barriers

- High capital and operating costs of producing and purifying PHAs in pure cultures using dedicated processes
- Optimization of waste treatment processes to produce PHA compositions suitable for competitive composite formulations (the mixed bacterial culture will vary between sites)
- Optimization of composite properties and processing using PHAs containing integrated cell debris

Pathways/Milestones

The objectives of this project will be achieved through (1) determining required PHA compositions, PHA/cell debris ratios, and PHA/wood ratios for production of competitive wood-plastic composites; (2) defining feedstock compositional ranges for pulp and paper effluents (PPE) and waste treatment effluents (WTE); (3) determining the efficacy of supplementing PPE and WTE to improve PHA production from these effluents; (4) testing the material properties of wood-PHA composites produced from waste-derived PHA made and used without extraction or purification; and (5) producing and testing wood-PHA composites made from wastewater-derived PHA at the pilot scale.

Commercialization

It is anticipated that successful proof of concept coupled with an aggressive marketing plan by capable partners, will introduce new wood-plastic composites by 2010. The industrial partners will have first right of refusal to license inventions by the Idaho National Laboratory, Washington State University, and the University of California-Davis; inventions not licensed by the industry partners will be made available to the forest products industry for licensing at the earliest practical time.

For additional information, please contact:

Drew Ronneberg, Ph.D.
Industrial Technologies Program
Phone: (202) 586-0205
Fax: (202) 586-9234
E-mail: Drew.Ronneberg@ee.doe.gov

David N. Thompson, Ph.D.
Idaho National Laboratory
Idaho Falls, ID
Phone: (208) 526-3977
Fax: (208) 526-0828
E-mail: David.Thompson@inl.gov

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

For more information contact:
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1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov

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